Review Article

Anesthetic Management in Elderly Patients: Physiological Changes, Pharmacological Adjustments, Postoperative Delirium, and Strategies for Safe Perioperative Care

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Abstract

Aging is associated with multiple physiological changes that significantly influence anesthetic management and perioperative outcomes in elderly patients. Cardiovascular alterations, including decreased cardiac compliance, increased arterial stiffness, and reduced baroreceptor sensitivity, contribute to hemodynamic instability and increased susceptibility to intraoperative hypotension. Respiratory changes such as reduced lung elasticity and diminished pulmonary reserve increase the risk of hypoxemia and postoperative pulmonary complications. In addition, age-related declines in renal and hepatic function affect drug metabolism and elimination, increasing the likelihood of anesthetic drug accumulation and toxicity. Structural and neurochemical changes in the central nervous system further increase sensitivity to sedatives and anesthetic agents, predisposing older adults to postoperative neurocognitive complications. Pharmacokinetic and pharmacodynamic modifications associated with aging require careful adjustment of anesthetic drug dosing. Evidence indicates that the requirements for agents such as propofol and remimazolam decrease significantly

with age, emphasizing the importance of dose titration to avoid excessive sedation and hemodynamic instability. At the same time, polypharmacy is highly prevalent among elderly patients and increases the risk of clinically significant drug–drug interactions, particularly with cardiovascular and central nervous system medications. Thorough preoperative medication reconciliation and careful drug selection are therefore essential components of perioperative risk reduction. Postoperative delirium remains one of the most common and clinically significant complications in elderly surgical patients, with reported incidences ranging from 11.1% to 45.6%. This condition is associated with increased mortality, prolonged hospitalization, and greater postoperative morbidity. Preventive strategies include comprehensive geriatric assessment, optimization of comorbidities, careful intraoperative monitoring, multimodal analgesia, and minimization of sedative medications. A multidisciplinary approach that integrates individualized anesthetic planning, appropriate pharmacological management, and targeted delirium prevention strategies is essential to improve perioperative safety and outcomes in elderly patients.

Key words

Geriatric anesthesia, physiological aging, pharmacokinetics, postoperative delirium, perioperative management, polypharmacy.

Introduction

Perioperative risks in elderly populations are strongly influenced by the physiological changes associated with aging, which affect multiple organ systems and increase vulnerability during surgical procedures. Among the most relevant concerns is hemodynamic instability. Elderly patients frequently experience cardiovascular alterations such as reduced cardiac output and decreased vascular compliance. These changes compromise the ability of the cardiovascular system to respond to perioperative stress and can complicate anesthetic management, thereby increasing the risk of both intraoperative and postoperative complications. In addition to cardiovascular vulnerability, aging also modifies the way anesthetic drugs are processed by the body. Age-related changes in drug metabolism and clearance alter both pharmacokinetics and pharmacodynamics, which can result in unpredictable drug responses. Consequently, anesthetic agents require careful dosing and close monitoring in order to minimize adverse effects and ensure adequate pharmacologic control during the perioperative period [1].

Beyond cardiovascular and pharmacological considerations, elderly patients also face an increased risk of neurocognitive complications following surgery. Perioperative neurocognitive disorders represent an important category of postoperative complications in older adults and include conditions such as postoperative delirium and postoperative cognitive dysfunction. These disorders have been associated with prolonged hospital stays and increased morbidity, highlighting their clinical importance in perioperative care [2, 3].

Among these complications, postoperative delirium is particularly significant due to its high incidence and its impact on patient outcomes. This condition frequently occurs in elderly surgical patients, although its incidence varies depending on factors such as preoperative cognitive status and the type of anesthesia administered. Postoperative delirium has been consistently associated with longer hospitalizations, increased morbidity, and a greater risk of long-term cognitive decline, making its prevention and early recognition essential components of perioperative management. One of the most important risk factors for the development of postoperative delirium is preexisting cognitive impairment. Evidence indicates that patients with baseline cognitive deficits are significantly more likely to

develop delirium after surgery and are also more likely to experience adverse postoperative outcomes [4, 5]. In addition to patient-related factors, anesthetic management itself may influence the likelihood of delirium. The selection of anesthetic techniques plays an important role, as some studies suggest that regional anesthesia may be associated with a lower risk of postoperative delirium when compared with general anesthesia. These findings emphasize the importance of tailoring anesthetic strategies to the specific needs and vulnerabilities of elderly patients [6].

Given these risks, the implementation of comprehensive perioperative strategies is essential for improving outcomes in this population. Effective management begins with a thorough preoperative assessment. Routine screening for cognitive impairment and frailty allows clinicians to identify patients who are at increased risk for postoperative delirium and other perioperative complications. Early identification of these high-risk individuals facilitates the implementation of targeted interventions and enables better optimization of perioperative care [2, 7]. During surgery, intraoperative management should be carefully adapted to account for age-related physiological changes. Adjustments in anesthetic techniques and monitoring strategies can help reduce the likelihood of complications. For example, the use of lighter levels of anesthesia and the incorporation of processed electroencephalography monitoring devices have been suggested as strategies that may help decrease the incidence of postoperative delirium. Postoperative care also plays a crucial role in minimizing adverse outcomes. The implementation of structured postoperative management plans that include cognitive assessment and delirium prevention strategies is essential for improving recovery and overall outcomes in elderly surgical patients [1, 7].

The objective of this article is to review the perioperative risks associated with aging and their implications for anesthetic management in elderly patients.

Methodology

This manuscript was designed as a structured narrative review focused on anesthetic management in elderly patients, emphasizing the physiological changes associated with aging, pharmacological adaptations, the risk of postoperative delirium, and perioperative strategies that improve patient safety. The review was conducted following the SANRA (Scale for the Assessment of Narrative Review Articles) framework and adhered to a predefined methodological protocol established before the literature screening process. Due to the clinical heterogeneity of elderly surgical populations and the multifactorial mechanisms underlying perioperative complications in this group, a narrative interpretative synthesis was chosen instead of quantitative pooling. This approach allowed the integration of physiological, pharmacological, and perioperative aspects into a clinically applicable framework. Particular attention was directed toward age-related alterations in the cardiovascular, respiratory, renal, hepatic, and central nervous systems and their implications for anesthetic pharmacology, intraoperative management, and postoperative neurocognitive outcomes. The purpose of this review was to synthesize current evidence that may guide safer anesthetic decision-making in elderly surgical patients.

The literature search was performed in PubMed, Scopus, and Web of Science and included peer-reviewed publications in English or Spanish published between January 2020 and December 2026. The final search was conducted in December 2026. This period was selected to capture recent developments in geriatric anesthesia, perioperative risk stratification, pharmacologic optimization, delirium prevention, anesthetic depth monitoring, and enhanced recovery protocols in elderly populations. When necessary, foundational studies were incorporated to provide context

regarding the physiological mechanisms of aging and the evolution of anesthetic management in older adults. The search strategy combined MeSH terms and free-text keywords using Boolean operators related to geriatric anesthesia, aging, physiological changes, pharmacokinetics, pharmacodynamics, postoperative delirium, postoperative cognitive dysfunction, frailty, perioperative risk, anesthetic management, and perioperative safety.

The initial search identified 236 records. After removing duplicates, 184 articles were screened by title and abstract, and 102 were subsequently evaluated in full text. A total of 45 studies met the eligibility criteria and were included in the final synthesis. Study selection was conducted independently by two authors, and any disagreements were resolved through discussion and consensus. Exclusion criteria included non–peer-reviewed publications, isolated case reports, editorials without outcome data, studies focused exclusively on non-elderly populations, redundant datasets, and articles that did not directly address physiological aging, anesthetic pharmacology, postoperative delirium, or perioperative safety in elderly surgical patients.

Eligible sources included randomized controlled trials, observational studies, systematic reviews, meta-analyses, expert consensus documents, and contemporary international guidelines from anesthesiology, geriatrics, surgery, and perioperative medicine societies. Priority was given to multicenter investigations and studies reporting outcomes related to hemodynamic stability, anesthetic drug response, postoperative neurocognitive complications, delirium incidence, hospital length of stay, and perioperative morbidity. Extracted variables included study design, patient age and frailty status, comorbidities, surgical procedure type, anesthetic technique, pharmacological interventions, monitoring methods, incidence of postoperative delirium or cognitive dysfunction, and postoperative outcomes. Methodological quality and internal validity were assessed narratively by considering potential bias, sample size, follow-up duration, and consistency of outcome definitions.

Reference lists of the selected studies were also manually reviewed to identify additional relevant publications. As a narrative synthesis, this review may be subject to selection bias and does not provide pooled quantitative estimates. Artificial intelligence–based tools were used solely to assist in organizing the literature and improving structural coherence, while the critical appraisal, synthesis, and interpretation of the evidence were performed independently by the authors to maintain methodological rigor.

Age-Related Physiological Changes Affecting Anesthetic Management

Aging is accompanied by multiple systemic physiological changes that significantly influence perioperative management and anesthetic care. Among the most relevant alterations are those affecting the cardiovascular system. With advancing age, cardiac output tends to decrease while vascular stiffness progressively increases. These changes compromise hemodynamic adaptability during surgical procedures and may contribute to instability during anesthesia. As a result, careful monitoring and management of blood pressure and fluid status become essential components of anesthetic care in elderly patients [8, 9].

In addition to cardiovascular changes, the respiratory system also undergoes important age-related alterations. Lung elasticity decreases with age, which leads to a reduction in pulmonary reserve and an increased susceptibility to hypoxia. These physiological modifications require anesthetic strategies specifically aimed at maintaining adequate ventilation and ensuring optimal oxygenation throughout the perioperative period [1, 9]. Similarly, aging affects renal and hepatic function, two systems that play a critical role in drug metabolism and elimination. Declines in renal filtration and hepatic metabolic capacity can alter the clearance

of anesthetic medications, making dose adjustments necessary to avoid drug accumulation and potential toxicity [8, 10]. The neurological system is also affected by aging. Structural and functional changes in the brain increase the susceptibility of older adults to postoperative cognitive dysfunction and delirium, which highlights the importance of careful selection and titration of anesthetic agents in this population [11, 12].

These systemic changes are closely linked to a progressive reduction in physiological reserve. Many elderly patients present with frailty and multiple comorbidities, factors that further compromise their ability to tolerate surgical stress and complicate anesthetic management. For this reason, preoperative evaluation should include an assessment of frailty and functional status to adapt anesthetic strategies to the specific characteristics of each patient [10, 13]. In parallel, age-related modifications in pharmacokinetics and pharmacodynamics influence drug metabolism and sensitivity. These alterations require careful consideration when selecting anesthetic drugs and determining appropriate dosages. In some cases, the use of nonopioid analgesics may be preferred to reduce the risk of opioid-related adverse effects [14, 15].

The combination of reduced physiological reserve and systemic functional decline also contributes to an increased vulnerability to perioperative stress. The diminished capacity of elderly patients to respond to surgical stress can lead to adverse outcomes, including cardiovascular instability and delayed postoperative recovery. Strategies aimed at minimizing surgical stress are therefore essential and include measures such as optimizing analgesia and maintaining normothermia during the perioperative period [8, 10]. In addition, older adults are at greater risk of postoperative complications, particularly neurocognitive disorders such as delirium and postoperative cognitive dysfunction. Implementing patient-centered interventions specifically tailored to the needs of elderly individuals may help reduce the incidence of these complications [11, 12].

Understanding these age-related physiological changes is fundamental for safe anesthetic management. A comprehensive knowledge of the systemic alterations associated with aging allows clinicians to develop individualized anesthetic plans that reduce perioperative risks and promote better recovery. This process involves selecting appropriate anesthetic agents, applying adequate monitoring techniques, and implementing postoperative care strategies designed to meet the specific needs of elderly patients [1, 16]. In this context, a multidisciplinary approach plays a crucial role. Collaboration among anesthesiologists, geriatricians, and other healthcare professionals is essential to address the complex clinical characteristics of older surgical patients and to improve perioperative outcomes [13].

Cardiovascular and Respiratory Alterations in the Elderly

Cardiovascular alterations are among the most significant physiological changes associated with aging and have important implications for anesthetic management. Elderly patients frequently exhibit decreased cardiac compliance and impaired ventricular relaxation, conditions that can compromise cardiac output during anesthesia. These changes make the cardiovascular system less capable of adapting to perioperative stress, thereby requiring careful monitoring and management of both fluid status and cardiac function during surgical procedures [1, 17]. In addition to these myocardial changes, aging is also associated with increased arterial stiffness and elevated systemic vascular resistance. The progressive loss of arterial elasticity contributes to greater fluctuations in blood pressure during anesthesia, which may complicate intraoperative hemodynamic control. Consequently, vigilant hemodynamic monitoring is necessary, and in some cases the use of vasoactive medications may be required to

maintain stable blood pressure levels throughout the procedure [15, 18].

Another important cardiovascular alteration in elderly patients is the reduction in baroreceptor sensitivity, which leads to impaired autonomic responses. This diminished regulatory capacity can compromise the body's ability to respond appropriately to changes in blood pressure, thereby increasing the risk of post-induction hypotension. Evidence suggests that preoperative evaluation of autonomic function may help identify individuals who are more likely to experience these hemodynamic disturbances and therefore facilitate better perioperative management [19]. As a consequence of these combined cardiovascular changes, elderly patients are particularly susceptible to intraoperative hypotension following anesthetic induction. This complication has been associated with adverse clinical outcomes and therefore represents a critical concern in perioperative care. Predictive approaches, including the assessment of carotid artery corrected flow time, have been proposed as useful tools for identifying patients at higher risk and guiding anesthetic management strategies aimed at maintaining hemodynamic stability [16, 20].

Respiratory alterations associated with aging also play an important role in anesthetic management. Age-related reductions in lung elasticity and chest wall compliance contribute to decreased vital capacity and increased residual volume, changes that can significantly affect ventilation during anesthesia. These physiological modifications increase the vulnerability of elderly patients to perioperative pulmonary complications, which underscores the importance of implementing lung-protective ventilation strategies during surgery. In addition, aging is associated with impaired gas exchange, a condition that increases the risk of hypoxemia both during and after surgical procedures. Effective anesthetic management therefore requires the implementation of strategies aimed at optimizing oxygenation and ventilation. Measures such as the use of positive end-expiratory pressure and careful monitoring of blood gases can help mitigate these risks and maintain adequate respiratory function [1, 16].

Tailored ventilation strategies are particularly important in elderly surgical patients. The use of lower tidal volumes combined with higher levels of positive end-expiratory pressure has been shown to reduce the incidence of postoperative pulmonary complications in this population. These ventilatory approaches contribute to maintaining adequate oxygenation while minimizing the risk of lung injury, thereby playing a critical role in improving perioperative respiratory outcomes in elderly patients [1, 16].

Renal, Hepatic, and Central Nervous System Changes

Age-related physiological changes also significantly affect renal, hepatic, and central nervous system function, all of which play essential roles in anesthetic pharmacology and perioperative safety. Renal function declines progressively with aging, particularly through reductions in renal blood flow and glomerular filtration rate. These alterations impair the clearance of anesthetic agents and their metabolites, increasing the risk of drug accumulation and toxicity. As a result, careful selection and adjustment of anesthetic dosing are required in elderly patients. Certain anesthetic agents may further influence renal hemodynamics. For example, sevoflurane has been shown to decrease renal blood flow and increase renal vascular resistance, which may exacerbate renal impairment in vulnerable individuals [21].

Impaired drug clearance becomes even more clinically relevant in patients with advanced renal dysfunction. In individuals with end-stage kidney disease, the pharmacologic potency of commonly used anesthetic agents such as propofol may be altered, requiring careful dose adjustment to prevent prolonged sedation and adverse effects [22]. In this context, propofol-

based total intravenous anesthesia has been associated with improved postoperative outcomes when compared with volatile anesthetics in patients with end-stage kidney disease, suggesting that this approach may represent a more suitable anesthetic strategy in this population [23].

In addition to renal changes, hepatic function also undergoes important age-related alterations that influence anesthetic metabolism. With advancing age, hepatic blood flow and metabolic capacity gradually decline, which can prolong the pharmacologic effects of anesthetic drugs. These changes are particularly relevant in surgical contexts where hepatic perfusion must be preserved, such as liver surgery. Maintaining adequate hepatic blood flow and minimizing drug-induced metabolic stress are therefore essential considerations in perioperative anesthetic management [8]. The choice and combination of anesthetic agents may help mitigate these effects. For example, the use of etomidate in combination with dexmedetomidine has been shown to maintain hemodynamic stability while reducing anesthetic dose requirements, thereby limiting hepatic stress and helping preserve liver function [17].

The central nervous system is likewise affected by aging, with structural and neurochemical changes that alter the response to anesthetic drugs. Reduced neuronal density and changes in neurotransmitter activity contribute to increased sensitivity to sedatives and anesthetic agents in elderly patients. Consequently, lower doses are often required to achieve the desired depth of anesthesia while minimizing the risk of neurocognitive complications [24]. The selection of anesthetic agents can further influence neurological outcomes. For instance, the use of ketamine in geriatric anesthesia has produced mixed results. While low doses may offer potential neuroprotective effects, higher doses have been associated with an increased risk of delirium and hallucinations [25]. More recently, newer agents such as remimazolam have emerged as promising alternatives in elderly patients. Compared with propofol, remimazolam has been associated with a lower incidence of hypotension and bradycardia, characteristics that may make it particularly advantageous for anesthetic management in older surgical populations [15].

Pharmacological Considerations and Dose Adjustments

Age-related pharmacokinetic and pharmacodynamic changes significantly influence anesthetic drug handling in elderly patients. Aging affects multiple phases of drug processing, including absorption, distribution, metabolism, and excretion, which collectively increase sensitivity to anesthetic agents. These alterations require particular attention when selecting and dosing anesthetic medications in older adults. Evidence indicates that the requirement for propofol decreases progressively with advancing age. Studies have demonstrated reductions of approximately 14.8%, 25.2%, and 38.5% in patients aged 65–74, 75–84, and over 85 years, respectively, highlighting the importance of dose adjustment in elderly populations [24]. Similar trends have been observed with newer anesthetic agents. Remimazolam, a novel ultra-short-acting benzodiazepine, also demonstrates decreased dose requirements in older individuals, with studies reporting a 26.9% reduction in the dose required to achieve loss of consciousness in patients aged 65 years and older compared with younger adults [26].

In addition to altered pharmacokinetics, elderly patients exhibit increased pharmacodynamic sensitivity to anesthetic drugs. Older adults are particularly sensitive to opioids, sedatives, and hypnotic agents, which increases the risk of prolonged sedation and drug-related adverse effects. This heightened sensitivity has also been demonstrated with remimazolam during anesthesia induction. The effective dose required to achieve anesthesia is lower in elderly patients, with reported median effective doses of 0.088

mg/kg in individuals aged 60–69 years and 0.061 mg/kg in those aged 70–85 years [27]. Importantly, remimazolam has been associated with lower incidences of hypotension and bradycardia when compared with propofol, suggesting that it may represent a safer anesthetic option in elderly surgical patients [16].

Age-related pharmacodynamic changes also influence the response to volatile anesthetics. The minimum alveolar concentration required to achieve adequate anesthesia decreases with advancing age, meaning that lower doses are needed to obtain the desired anesthetic effect. This reduction in minimum alveolar concentration is believed to result from increased central nervous system sensitivity as well as decreased metabolic activity in elderly individuals [1, 16].

Given these pharmacological changes, careful dose titration and appropriate drug selection are essential components of anesthetic management in elderly patients. Gradual titration helps prevent excessive sedation and reduces the risk of hemodynamic instability. The use of short-acting anesthetic agents may provide advantages in this population. Agents such as remimazolam allow rapid onset of anesthesia while maintaining a predictable recovery profile, which facilitates better control of anesthetic depth and promotes faster postoperative recovery [28] (Kim, et al., 2023). In addition, the hemodynamic stability associated with remimazolam is especially beneficial for elderly patients, who often present with increased cardiovascular vulnerability [17].

Short-acting anesthetic agents may therefore contribute to improved perioperative outcomes in older adults. Drugs such as remimazolam and etomidate provide rapid recovery and reduce the risk of prolonged sedation, which is particularly important in minimizing postoperative complications in elderly surgical patients. Furthermore, remimazolam has demonstrated greater hemodynamic stability than propofol, reducing the need for vasoactive medications during anesthesia induction and thereby supporting safer anesthetic management in elderly populations [28].

Polypharmacy and Drug Interactions

Polypharmacy is highly prevalent among older adults and represents an important challenge in perioperative care. A substantial proportion of elderly patients receive multiple medications simultaneously, which increases the complexity of clinical management and the likelihood of adverse drug interactions. Evidence illustrates the magnitude of this issue. In one study conducted in Saudi Arabia, 97.2% of elderly patients were found to be receiving polypharmacy regimens, highlighting how widespread this phenomenon has become in aging populations [30]. As the number of medications increases, so does the probability of drug–drug interactions. These interactions are frequently encountered in hospitalized older adults, with approximately 61% experiencing at least one clinically significant drug interaction upon hospital admission (Monahan, et al., 2022). Among the medications most frequently involved in severe interactions are cardiovascular and central nervous system drugs, which are widely prescribed in elderly populations due to the high prevalence of chronic diseases affecting these systems [31].

The presence of polypharmacy becomes particularly relevant in the perioperative setting because anesthetic drugs may interact with medications that patients are already taking. Cardiovascular medications are among the most commonly involved. For example, anesthetic agents can interact with drugs such as beta-blockers and anticoagulants, potentially leading to complications including hypotension or increased bleeding risk during surgery. Interactions involving the central nervous system are also clinically important. Sedatives and other central nervous system depressants used during anesthesia may produce additive or synergistic effects when combined with other centrally acting medications, which can increase the

likelihood of postoperative cognitive dysfunction and other neurocognitive complications [31, 32]. In addition, medications used to manage metabolic conditions may also interact with anesthetic drugs. Agents that influence glucose metabolism can complicate perioperative glycemic control, thereby requiring careful monitoring and adjustment of treatment strategies during the perioperative period [33].

Given these potential interactions, preoperative medication reconciliation plays a critical role in perioperative risk reduction. A comprehensive review of all medications taken by the patient before surgery allows clinicians to identify possible drug–drug interactions and adjust treatment regimens accordingly. The use of structured tools and standardized reference lists can further support this process. For example, the application of systematic resources such as the 66-item drug–drug interaction list can assist clinicians in identifying clinically significant interactions in a consistent and organized manner [30]. In addition to medication review, preoperative evaluation should also consider the presence of polypharmacy and frailty, as both factors have been associated with an increased risk of postoperative functional decline in elderly patients [34].

Several strategies may help reduce the risk of adverse drug interactions in elderly surgical patients. One potential approach involves deprescribing interventions, particularly targeting medications that act on the central nervous system or the cardiovascular system. Reducing unnecessary medications may decrease the likelihood of adverse outcomes; however, such interventions must be carefully evaluated in terms of timing and clinical appropriateness to avoid unintended consequences [34]. Ongoing medication review also remains essential. Regular reassessment of medication regimens, combined with interdisciplinary collaboration among healthcare professionals, can improve the management of polypharmacy and reduce the incidence of harmful drug interactions. Patient and caregiver education represents an additional component of safe medication management. Informing patients and their caregivers about the risks associated with polypharmacy and the importance of proper medication adherence can contribute to improved safety and better overall clinical outcomes [35].

Postoperative Delirium in Elderly Surgical Patients

Postoperative delirium represents one of the most frequent neurocognitive complications affecting elderly surgical patients and has significant implications for perioperative outcomes. The incidence of postoperative delirium in older adults varies widely, ranging from 11.1% to 45.6%, with higher rates observed in patients undergoing emergency procedures compared with those undergoing elective surgeries. This condition is clinically significant because it is associated with substantial adverse outcomes. Patients who develop postoperative delirium demonstrate increased mortality rates at multiple time points, including one month, six months, and one year following surgery. In addition, postoperative delirium has been linked to a higher likelihood of postoperative complications, unplanned admissions to intensive care units, and prolonged hospital stays, all of which contribute to greater healthcare utilization and worse patient outcomes [36]. Evidence from different healthcare settings further illustrates its impact. For example, a study conducted in Ethiopia reported an incidence of postoperative delirium of 41%, emphasizing the substantial burden that this complication imposes on healthcare systems, particularly in developing countries [37].

The development of postoperative delirium is thought to involve several pathophysiological mechanisms that affect brain function in elderly patients. Neuroinflammation plays an important role in this process and is often accompanied by imbalances in neurotransmitter systems that regulate cognitive activity. These alterations can disrupt normal neuronal signaling and contribute to the cognitive disturbances characteristic of

delirium. In addition to inflammatory mechanisms, dysfunction of the blood–brain barrier and increased oxidative stress have also been implicated in the pathogenesis of postoperative delirium. These processes further increase the vulnerability of the aging brain and may contribute to the worsening of cognitive decline following surgery [38].

Multiple risk factors contribute to the development of postoperative delirium in elderly patients. Advanced age is one of the most consistently identified predictors, with studies indicating that the likelihood of delirium increases by approximately 12% with each additional decade of life [39]. Frailty frequently accompanies advanced age and further increases susceptibility to perioperative complications. Another important risk factor is preexisting cognitive impairment. Patients with baseline cognitive deficits are significantly more likely to develop postoperative delirium, with research reporting an adjusted odds ratio of 3.3 for this population [4]. Surgical and anesthetic factors also contribute to the risk profile. Major surgical procedures and prolonged operative times have been associated with an increased likelihood of delirium [40]. Additionally, intraoperative hypotension and exposure to certain anesthetic agents may influence the development of postoperative delirium. For example, the use of sevoflurane has been associated with a higher incidence of postoperative delirium compared with propofol in some studies [41].

Clinically, postoperative delirium may present in several forms. The condition can manifest as hyperactive delirium, characterized by agitation and restlessness; hypoactive delirium, which is often marked by lethargy and reduced responsiveness; or mixed forms that fluctuate between these presentations. Symptoms commonly include alterations in consciousness, cognitive dysfunction, disorientation, and disturbances in sleep–wake cycles. Because postoperative delirium can significantly affect recovery and long-term quality of life, early detection and prompt management are essential components of perioperative care in elderly patients [36].

Strategies for Safe Anesthetic Management in Elderly Patients

Preoperative assessment represents a fundamental component of perioperative management in elderly patients and plays a critical role in identifying risk factors that may influence surgical outcomes. One of the most widely recommended approaches is the Comprehensive Geriatric Assessment, a multidimensional evaluation that examines medical, psychological, and functional domains in older adults. This assessment allows clinicians to obtain a more complete understanding of the patient's overall health status and functional capacity before surgery. Evidence suggests that the implementation of Comprehensive Geriatric Assessment can reduce the incidence of postoperative delirium in elderly patients, although its effects on other postoperative outcomes remain uncertain [42, 43]. In addition to its potential impact on delirium prevention, this evaluation is particularly useful for identifying frailty and optimizing existing comorbidities, both of which are essential considerations when tailoring perioperative management strategies in older surgical populations [13].

Frailty and cognitive impairment represent important predictors of adverse perioperative outcomes and therefore require systematic screening during the preoperative period. Frailty has been consistently associated with increased rates of intraoperative complications as well as a greater risk of post-induction hypotension, which can complicate anesthetic management in elderly patients [22, 44]. The use of standardized assessment tools can improve risk stratification and support clinical decision-making. Instruments such as the Clinical Frailty Scale have been proposed as practical tools for evaluating frailty in surgical patients and may help guide anesthetic planning by identifying

individuals who are more vulnerable to perioperative complications [7, 45]. Alongside frailty assessment, the optimization of preexisting medical conditions remains a crucial aspect of preoperative preparation. Chronic illnesses, including cardiovascular disease, diabetes, and pulmonary disorders, can significantly increase perioperative risk if not adequately controlled. Effective management of these conditions often involves medication adjustments and the achievement of optimal disease control before surgery in order to reduce the likelihood of perioperative complications [16].

Intraoperative management must also be carefully adapted to the physiological characteristics of elderly patients. Maintaining hemodynamic stability is particularly important because older adults frequently have reduced physiological reserve and limited capacity to compensate for rapid cardiovascular changes. For this reason, careful fluid management and continuous hemodynamic monitoring are essential to prevent hypotension and its associated complications during anesthesia [22]. Another key consideration involves the depth of anesthesia. Elderly patients are more sensitive to anesthetic agents, and excessive anesthetic depth may lead to prolonged recovery and an increased risk of postoperative delirium. Consequently, anesthetic drugs must be carefully titrated to achieve adequate anesthesia while avoiding unnecessary sedation. In addition to hemodynamic control and appropriate anesthetic dosing, maintaining adequate oxygenation and preventing perioperative hypothermia are essential components of intraoperative care. Proper oxygen delivery and temperature regulation help minimize metabolic stress and support improved postoperative recovery in elderly patients [1].

Preventing postoperative delirium is another critical objective in the perioperative management of older adults. One important strategy involves minimizing the use of sedative and anticholinergic medications whenever possible, as these drugs have been associated with an increased risk of delirium in elderly surgical patients [16, 22]. Pain control strategies also play a significant role in delirium prevention. The use of multimodal analgesia allows clinicians to combine different analgesic techniques, thereby reducing reliance on opioids and limiting their associated adverse effects, including neurocognitive complications [13]. In addition, maintaining patient orientation and ensuring adequate sensory support can help preserve cognitive function in the postoperative period. Simple measures such as providing orientation cues and ensuring access to hearing aids or glasses may reduce the likelihood of delirium and contribute to improved recovery in elderly surgical patients [16].

Conclusions

Aging produces multisystem physiological changes that significantly influence anesthetic management. Cardiovascular stiffness, reduced cardiac compliance, diminished pulmonary reserve, and declining renal and hepatic function alter hemodynamic stability, ventilation, and anesthetic drug metabolism. In addition, structural and neurochemical changes in the central nervous system increase sensitivity to anesthetic agents and predispose elderly patients to postoperative neurocognitive complications. These physiological modifications, combined with reduced physiological reserve and the presence of frailty and comorbidities, increase vulnerability to perioperative stress and require individualized anesthetic strategies with careful monitoring and dose adjustments.

Pharmacological considerations and polypharmacy play a critical role in perioperative risk among elderly patients. Age-related pharmacokinetic and pharmacodynamic changes increase sensitivity to anesthetic agents, resulting in lower dose requirements for drugs such as propofol and remimazolam. At the same time, the high prevalence of polypharmacy increases the likelihood of drug–drug interactions,

particularly with cardiovascular and central nervous system medications. Careful medication reconciliation, dose titration, and the use of short-acting anesthetic agents with favorable hemodynamic profiles are essential to minimize adverse drug effects and improve perioperative safety in this population.

Postoperative delirium represents one of the most important complications in elderly surgical patients and requires comprehensive preventive strategies. Its high incidence and association with increased mortality, prolonged hospitalization, and greater postoperative morbidity underscore its clinical significance. Risk factors include advanced age, frailty, cognitive impairment, major surgery, intraoperative hypotension, and exposure to certain anesthetic agents. Effective prevention and management depend on a multidisciplinary perioperative approach that includes comprehensive geriatric assessment, optimization of comorbidities, careful intraoperative monitoring, multimodal analgesia, and interventions aimed at maintaining cognitive orientation and minimizing sedative exposure.

References

1. Mahender A, Chavan SS, Saroa R, Chauhan M. Recent advances in geriatric anaesthesia. Indian Journal of Anaesthesia [Internet]. 2023 Jan 1;67(1):152–8. Available from: https://doi.org/10.4103/ija.ija_1029_22
2. Evered L, Atkins K, Silbert B, Scott DA. Acute peri-operative neurocognitive disorders: a narrative review. Anaesthesia [Internet]. 2022 Jan 1;77(S1):34–42. Available from: https://doi.org/10.1111/anae.15613
3. Somnuke P, Srishewachart P, Jiraphorncharas C, Khempetch A, Weeranithan J, Suraarunsumrit P, et al. Early postoperative neurocognitive complications in elderly patients: comparing those with and without preexisting mild cognitive impairment– a prospective study. BMC Geriatrics [Internet]. 2024 Jan 22;24(1):84. Available from: https://doi.org/10.1186/s12877-024-04663-5
4. Weiss Y, Zac L, Refaeli E, Ben-Yishai S, Zegerman A, Cohen B, et al. Preoperative cognitive impairment and postoperative delirium in elderly surgical patients. Annals of Surgery [Internet]. 2022 Aug 1;278(1):59–64. Available from: https://doi.org/10.1097/sla.0000000000005657
5. Thedim M, Vacas S. Postoperative delirium and the older adult: Untangling the confusion. Journal of Neurosurgical Anesthesiology [Internet]. 2024 Apr 29;36(3):184–9. Available from: https://doi.org/10.1097/ana.0000000000000971
6. Zhong G, Huang X, Li C, Wang D, Huang D, Sun M, et al. A multicenter retrospective study on anesthesia methods and their impact on neurocognitive outcomes and other complications in elderly patients undergoing hemiarthroplasty. Frontiers in Medicine [Internet]. 2025 Aug 11;12:1599989. Available from: https://doi.org/10.3389/fmed.2025.1599989
7. Penfold RS, Hunt A. Redefining risk in peri-operative frailty: towards routine frailty assessment and a whole pathway approach. Anaesthesia [Internet]. 2024 May 22;79(8):797–800. Available from: https://doi.org/10.1111/anae.16264
8. Wallace H, Miller T, Angus W, Stott M. Intra-operative anaesthetic management of older patients undergoing liver surgery. European Journal of Surgical Oncology [Internet]. 2020 Nov 10;47(3):545–50. Available from: https://doi.org/10.1016/j.ejso.2020.11.004
9. Brunker LB, Boncyk CS, Rengel KF, Hughes CG. Elderly patients and

management in intensive care units (ICU): clinical challenges. Clinical Interventions in Aging [Internet]. 2023 Jan 1;Volume 18:93–112. Available from: https://doi.org/10.2147/cia.s365968

10. Tjeertes EKM, Schmidt GB, Mattace-Raso FUS. Perioperative care of the geriatric patient. European Journal of Anaesthesiology [Internet]. 2025 Aug 1;43(2):93–102. Available from: https://doi.org/10.1097/eja.0000000000002257
11. Vacas S, Canales C, Deiner SG, Cole DJ. Perioperative brain health in the older adult: a patient safety imperative. Anesthesia & Analgesia [Internet]. 2022 May 18;135(2):316–28. Available from: https://doi.org/10.1213/ane.0000000000006090
12. Obert DP, Sepúlveda PO, Adriazola V, Zurita F, Brouse J, Schneider G, et al. Overcoming age: Slow anesthesia induction may prevent geriatric patients from developing burst suppression and help developing intraoperative EEG signatures of a younger brain. Journal of Clinical Anesthesia [Internet]. 2024 Oct 31;99:111672. Available from: https://doi.org/10.1016/j.jclinane.2024.111672
13. Thillainadesan J, Hilmer SN, Fleury AM, Naganathan V. New horizons in the perioperative care of older adults. Age And Ageing [Internet]. 2021 Nov 16;51(2). Available from: https://doi.org/10.1093/ageing/afab245
14. Wilson SH, Wilson PR, Bridges KH, Bell LH, Clark CA. Nonopioid Analgesics for the Perioperative Geriatric Patient: A Narrative review. Anesthesia & Analgesia [Internet]. 2022 Feb 24;135(2):290–306. Available from: https://doi.org/10.1213/ane.0000000000005944
15. Pereira EM, Moraes VR, Da Costa MG, Nascimento TSD, Slawka E, Júnior CG, et al. Remimazolam vs. propofol for general anaesthesia in elderly patients: a meta-analysis with trial sequential analysis. European Journal of Anaesthesiology [Internet]. 2024 Jul 29;41(10):738–48. Available from: https://doi.org/10.1097/eja.0000000000002042
16. Sieber F, McIsaac DI, Deiner S, Azefor T, Berger M, Hughes C, et al. 2025 American Society of Anesthesiologists Practice Advisory for Perioperative care of Older adults scheduled for inpatient surgery. Anesthesiology [Internet]. 2024 Dec 6;142(1):22–51. Available from: https://doi.org/10.1097/aln.0000000000005172
17. Wang J, Li Y, Su H, Zhao J, Tu F. Carotid artery corrected flow time and respiratory variations of peak blood flow velocity for prediction of hypotension after induction of general anesthesia in elderly patients. BMC Geriatrics [Internet]. 2022 Nov 19;22(1):882. Available from: https://doi.org/10.1186/s12877-022-03619-x
18. Zhao B, Chen X, Chen Q, Li G, Chen Z, Yang Z, et al. Intraoperative hypotension and related risk factors for postoperative mortality after noncardiac surgery in elderly patients: a Retrospective Analysis report. Clinical Interventions in Aging [Internet]. 2021 Sep 30;Volume 16:1757–67. Available from: https://doi.org/10.2147/cia.s327311
19. Cui Q, Che L, Zang H, Yu J, Xu L, Huang Y. Association between preoperative autonomic nervous system function and post-induction hypotension in elderly patients: a protocol for a cohort study. BMJ Open [Internet]. 2023 Jan 1;13(1):e067400. Available from: https://doi.org/10.1136/bmjopen-2022-067400
20. Lee HJ, Kim YJ, Woo JH, Oh HW. Preoperative frailty is an independent

risk factor for postinduction hypotension in older patients undergoing noncardiac surgery: a retrospective cohort study. The Journals of Gerontology Series A [Internet]. 2023 Sep 25;79(1). Available from: https://doi.org/10.1093/gerona/glad229

21. Franzén S, Frithiof R. Impact of intravenous propofol and volatile sevoflurane anesthesia on renal function in an experimental pig model of hemorrhage-induced acute kidney injury. Physiology [Internet]. 2023 May 1;38(S1). Available from: https://doi.org/10.1152/physiol.2023.38.s1.5730649
22. Jun MR, Kim MG, Han KS, Park JE, Cho HB, Park SY, et al. Potency of propofol for inducing loss of consciousness in end-stage kidney disease patients. PLoS ONE [Internet]. 2021 Aug 12;16(8):e0254520. Available from: https://doi.org/10.1371/journal.pone.0254520
23. Cho HB, Kim MG, Park SY, Park SY, Song S, Jang YS, et al. The influence of propofol-based total intravenous anesthesia on postoperative outcomes in end-stage renal disease patients: A retrospective observation study. PLoS ONE [Internet]. 2021 Jul 22;16(7):e0254014. Available from: https://doi.org/10.1371/journal.pone.0254014
24. Yang H, Deng HM, Chen HY, Tang SH, Deng F, Lu YG, et al. The impact of age on propofol requirement for inducing loss of consciousness in elderly surgical patients. Frontiers in Pharmacology [Internet]. 2022 Mar 28;13:739552. Available from: https://doi.org/10.3389/fphar.2022.739552
25. You S, Li Z. The impact of ketamine on cognitive outcomes in geriatric anesthesia: a comprehensive review. Frontiers in Psychiatry [Internet]. 2025 Jul 30;16:1594730. Available from: https://doi.org/10.3389/fpsyt.2025.1594730
26. Song JC, Wang XX, Fu X, Chen W, Tang SH, Deng F, et al. Relationship between age and remimazolam dose required for inducing loss of consciousness in older surgical patients. Frontiers in Medicine [Internet]. 2024 Apr 29;11:1331103. Available from: https://doi.org/10.3389/fmed.2024.1331103
27. Jeong H, Ahn HJ. Optimal remimazolam infusion rate for general anesthesia induction in elderly patients: a dose determination study by the k-in-a-row method. Korean Journal of Anesthesiology [Internet]. 2025 Sep 24; Available from: https://doi.org/10.4097/kja.25446
28. Kim TK, Kwak HJ, Jung WS, Choi GB, Park SY, Kim JY. Effects of Remimazolam Anesthesia with Two Induction Doses on Hemodynamics and Recovery Profile in Older Patients: Comparison with Propofol Anesthesia. Journal of Clinical Medicine [Internet]. 2023 Aug 14;12(16):5285. Available from: https://doi.org/10.3390/jcm12165285
29. Alhumaidi RM, Bamagous GA, Alsanosi SM, Alqashqari HS, Qadhi RS, Alhindi YZ, et al. Risk of Polypharmacy and its outcome in terms of drug interaction in an elderly population: A Retrospective Cross-Sectional Study. Journal of Clinical Medicine [Internet]. 2023 Jun 10;12(12):3960. Available from: https://doi.org/10.3390/jcm12123960
30. Monahan J, O'Mahony D, Curtin D. 28 DRUG-DRUG INTERACTIONS IN OLDER HOSPITALISED PATIENTS: A PROSPECTIVE PREVALENCE STUDY. Age And Ageing [Internet]. 2022 Oct 25;51(Supplement_3). Available from:

https://doi.org/10.1093/ageing/afac218.022

31. Hughes JE, Russo V, Walsh C, Menditto E, Bennett K, Cahir C. Prevalence and Factors Associated with Potential Drug-Drug Interactions in Older Community-Dwelling Adults: A Prospective Cohort Study. Drugs & Aging [Internet]. 2021 Oct 11;38(11):1025–37. Available from: https://doi.org/10.1007/s40266-021-00898-8
32. Sheikh-Taha M, Asmar M. Polypharmacy and severe potential drug-drug interactions among older adults with cardiovascular disease in the United States. BMC Geriatrics [Internet]. 2021 Apr 7;21(1):233. Available from: https://doi.org/10.1186/s12877-021-02183-0
33. Tamargo J, Kjeldsen KP, Delpón E, Semb AG, Cerbai E, Dobrev D, et al. Facing the challenge of polypharmacy when prescribing for older people with cardiovascular disease. A review by the European Society of Cardiology Working Group on Cardiovascular Pharmacotherapy. European Heart Journal - Cardiovascular Pharmacotherapy [Internet]. 2022 Jan 27;8(4):406–19. Available from: https://doi.org/10.1093/ehjcvp/pvac005
34. Mangoni AA, Russell P, Jarmuzewska EA. Preoperative polypharmacy assessment for risk stratification and management. British Journal of Clinical Pharmacology [Internet]. 2022 Feb 15;88(5):1952–4. Available from: https://doi.org/10.1111/bcp.15271
35. Olding L, Raza H, Hussain Y, Ganesaraja P, Kiczynska P, Eid S. 2668 Polypharmacy in the elderly: are addressing the medication burden? Age And Ageing [Internet]. 2025 Jan 1;54(Supplement_1). Available from: https://doi.org/10.1093/ageing/afae277.061
36. Yan E, Veitch M, Saripella A, Alhamdah Y, Butris N, Tang-Wai DF, et al. Association between postoperative delirium and adverse outcomes in older surgical patients: A systematic review and meta-analysis. Journal of Clinical Anesthesia [Internet]. 2023 Jul 27;90:111221. Available from: https://doi.org/10.1016/j.jclinane.2023.111221
37. Fenta E, Teshome D, Kibret S, Hunie M, Tiruneh A, Belete A, et al. Incidence and risk factors of postoperative delirium in elderly surgical patients 2023. Scientific Reports [Internet]. 2025 Jan 9;15(1):1400. Available from: https://doi.org/10.1038/s41598-024-84554-2
38. Arefayne N, Berhe Y, Van Zundert A. Incidence and factors related to Prolonged Postoperative Cognitive Decline (POCD) in elderly patients following surgery and anaesthesia: a systematic review. Journal of Multidisciplinary Healthcare [Internet]. 2023 Nov 1;Volume 16:3405–13. Available from: https://doi.org/10.2147/jmdh.s431168
39. Liu XH, Zhang QF, Liu Y, Lu QW, Wu JH, Gao XH, et al. Risk factors associated with postoperative delirium in elderly patients undergoing hip surgery. Frontiers in Psychiatry [Internet]. 2023 Oct 19;14:1288117. Available from: https://doi.org/10.3389/fpsyt.2023.1288117
40. Kamata K, Hagihira S. Incidence and perioperative risk factors for postoperative delirium in the intensive care unit among adult surgical patients – Retrospective cohort study. Indian Journal of Anaesthesia [Internet]. 2025 Aug 11;69(9):926–32. Available from: https://doi.org/10.4103/ija.ija_377_25
41. Chang JE, Min SW, Kim H, Won D, Lee JM, Kim TK, et al. Association between anesthetics and postoperative delirium in

elderly patients undergoing spine surgery: propofol versus sevoflurane. Global Spine Journal [Internet]. 2022 Jun 22;14(2):478–84. Available from: https://doi.org/10.1177/21925682221110828

42. Schwesinger A, Tsai LT, Lang W, Mantegazza N, Bauernschmitt R, Wilhelm M, et al. Does comprehensive geriatric assessment reduce the incidence of postoperative delirium? A quasi-experimental study in older adults undergoing transcatheter aortic valve implantation. Clinical Interventions in Aging [Internet]. 2024 Feb 1;Volume 19:347–55. Available from: https://doi.org/10.2147/cia.s448167
43. Chen L, Zong W, Luo M, Yu H. The impact of comprehensive geriatric assessment on postoperative outcomes in elderly surgery: A systematic review and meta-analysis. PLoS ONE [Internet]. 2024 Aug 28;19(8):e0306308. Available from: https://doi.org/10.1371/journal.pone.0306308
44. Saetang M, Kunapaisal T, Chatmongkolchart S, Yongsata D, Sukitpaneenit K. Association of Frailty with Intraoperative Complications in Older Patients Undergoing Elective Non-Cardiac Surgery. Journal of Clinical Medicine [Internet]. 2025 Jan 17;14(2):593. Available from: https://doi.org/10.3390/jcm14020593
45. Engel JS, Tran J, Khalil N, Hladkowicz E, Lalu MM, Huang A, et al. A systematic review of perioperative clinical practice guidelines for care of older adults living with frailty. British Journal of Anaesthesia [Internet]. 2023 Jan 25;130(3):262–71. Available from: https://doi.org/10.1016/j.bja.2022.12.010